Draft Comprehensive National Energy Strategy

January 30, 1998

About This Document

The Department of Energy is currently developing, in conjunction with other Federal agencies, a Comprehensive National Energy Strategy (CNES), which is required periodically by law. This general framework was produced as a means of eliciting comments from the public and Federal agencies. Comments are welcome on any aspect of the framework, including suggestions for additional detail to accompany the strategies.

Comments are needed by February 27, 1998, and can be submitted in several ways, including:

- E-mail: http://www.eren.doe.gov/nes.html
- Fax: 202-737-0219
- Mail: USDOE ATTN: CNES Hearings (PO-4)
  1000 Independence Avenue, SW, Room 7B-044
  Washington, DC 20585

Regional hearings will be held during February 9–20, 1998, to provide the public with an opportunity to give oral comments on the CNES. More information on these hearings can be obtained:

- At the web site: http://www.eren.doe.gov/nes.html, or
- By sending fax inquiries to: CNES HEARINGS at 202-737-0219 or 202-586-4025.

Comprehensive National Energy Strategy

Energy—the Economy's Lifeblood

Americans share a desire for a high quality of life, characterized by good health, prosperity, security, and a clean environment. Government seeks to create conditions where these shared dreams have the greatest chance of being realized. Good energy policy is an enabler for each of these facets of the American dream. It is no exaggeration to say that energy is the lifeblood of modern economies. Energy powers our factories, heats and cools our homes, and moves people and goods — all with the flick of a switch or turn of an ignition key. The lifestyle U.S. citizens enjoy, which is the envy of much of the world, was built in large measure on reliable and low-cost energy supplies. Each day, Americans depend on the benefits of energy, without always being aware of the role it plays in sustaining the very quality of the lives we lead.

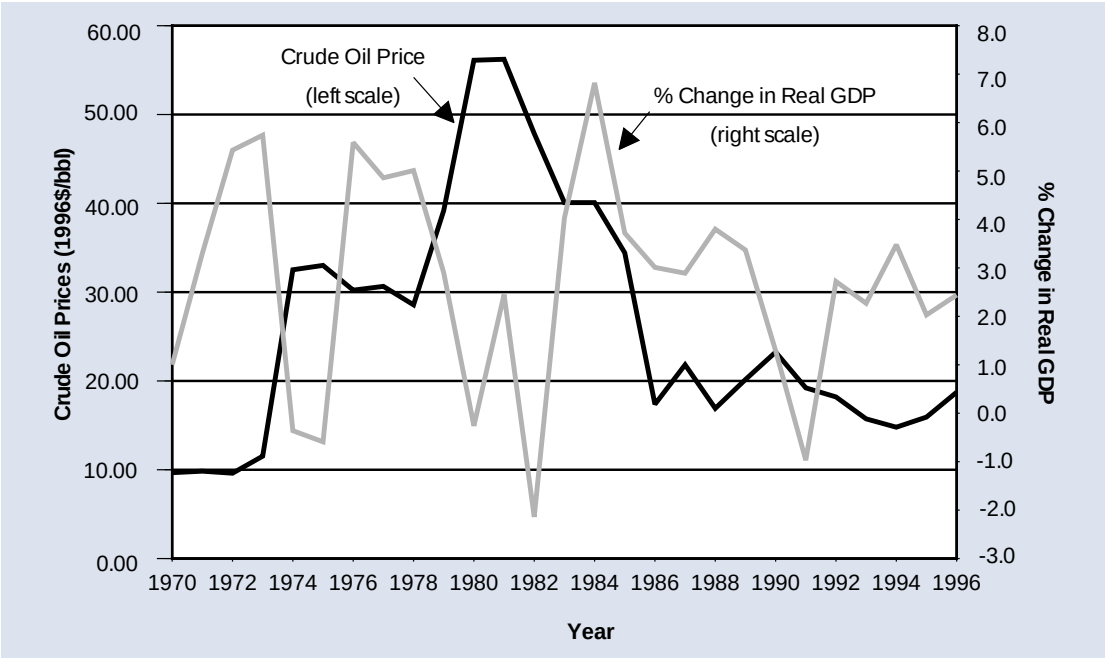
Energy is a global commodity. The price and availability of energy resources in one region can have global implications. Complacency about energy availability was shaken during the economic recessions that followed the two oil shocks experienced in the 1970s. The 1973 Arab Oil Embargo and the 1978 Iranian Revolution showed how events thousands of miles away and largely outside our control can disrupt our daily lives through impacts on energy markets. More recently, Operation Desert Shield/Desert Storm in 1991 provided a vivid reminder that our energy situation cannot be taken for granted. [Fig. 1.]

The 1970s also witnessed broad recognition of the environmental consequences of energy use, such as urban smog and acid rain. New laws were enacted to counter the pollution from energy production and use. These were effective at lowering emissions and improving health, yielding substantial benefits that far exceed the incurred costs. This period also saw the dawning realization that greenhouse gas emissions from fossil fuel use could have global environmental implications.

During the late 1970s, it became apparent that the decades-old regulation of many energy prices was counterproductive and that the Nation should pursue market-oriented approaches to energy supply and use wherever possible. A consensus developed that competitive markets should be the cornerstone of a successful energy policy, but also that markets alone cannot be relied upon to achieve all of society's economic, environmental, and security goals. By themselves, markets cannot produce adequate amounts of energy security, environmental quality, and energy research, because these societal benefits often are undervalued by the private sector. The role of government in energy is now focused on the important tasks of improving the operation of competitive markets and addressing the market's inherent limits. This combined approach allows markets largely to determine supply and demand while government guides market forces through policies that bolster energy security, provide for a cleaner environment, and nurture energy research.

In this context, the Federal Government focuses on augmenting energy security by

Figure 1
Real world oil prices, superimposed with change in real GDP, 1970–1996



maintaining the Strategic Petroleum Reserve, coordinating emergency responses with our allies, promoting increased domestic oil and gas production and use of alternative fuels, and maintaining military preparedness. The Government also reduces negative environmental effects through regulating pollution and limiting access to environmentally sensitive public lands and waters and by setting standards for energy use in consultation with the private sector. And the Government ensures the flow of new and cleaner energy technologies by funding energy research, development, and demonstration, often in concert with the private sector. Ultimately, the continued development of new technologies that provide diverse energy sources, improve the efficiency of end-use, and reduce the negative environmental effects of energy production and use is the key to maintaining our high quality of life. [Figs. 2A and 2B.]

This market-oriented approach to energy policy has proven quite adaptable to changing economic, energy, and environmental circumstances. For example, by the late 1970s and early 1980s, succeeding Administrations allowed the price of oil products to rise as world oil prices increased. This policy encouraged consumers to reduce oil consumption and gave producers incentives to boost production, both here and around the world. From the mid-1970s to the mid-1980s, American energy efficiency relative to the level of economic activity improved by about 30 percent. These market adjustments ultimately helped erode OPEC's monopoly power in oil markets and paved the way for today's lower world oil prices. Energy technologies developed through government support have allowed the Nation to produce and use energy more efficiently and cleanly. And, in large part due to government actions, emissions of the most harmful pollutants from energy use have declined steadily in the United States even as our economy and energy consumption have grown.

A Changing Energy World

Growing populations and rising living standards, economies transitioning to market-based systems, and increasing globalization of energy markets demand greater flexibility and creativity in government economic, environmental, foreign, and national security policies. Energy policies, too, must be reevaluated in the wake of the experiences of the 1990s. Three challenges are pre-eminent: how to maintain energy security in global energy markets; how to successfully harness competition in electricity markets; and how to respond to the threat of climate change.

Figure 2A
Total energy R&D spending by the U.S. government and private sector, 1978–98

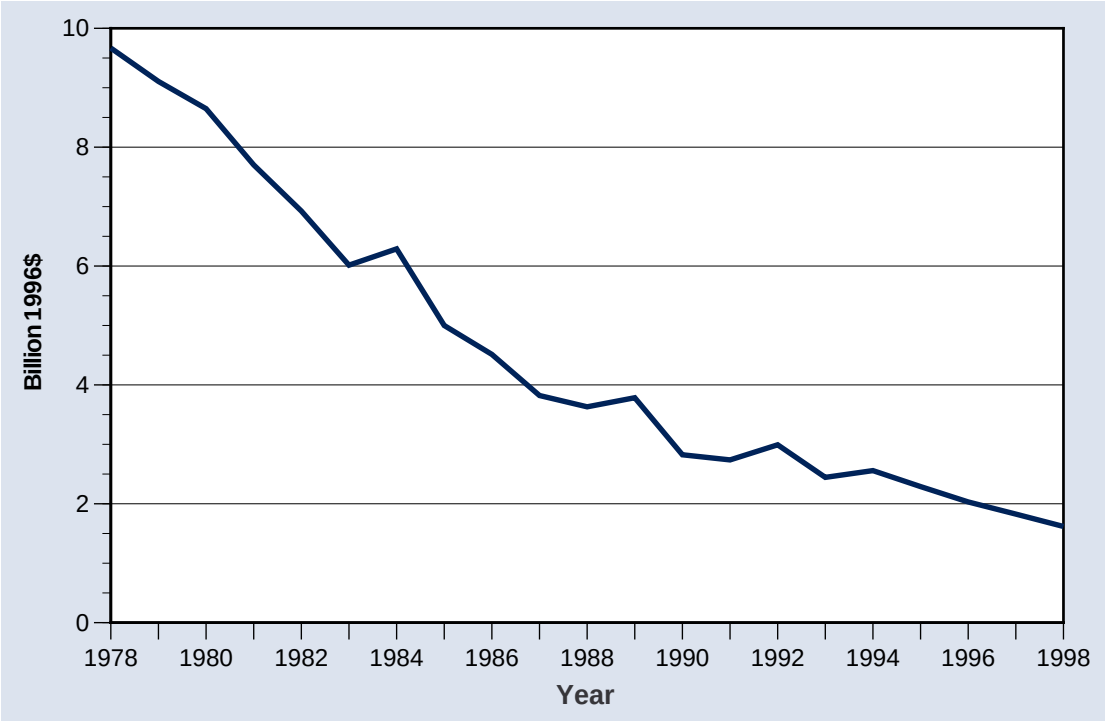
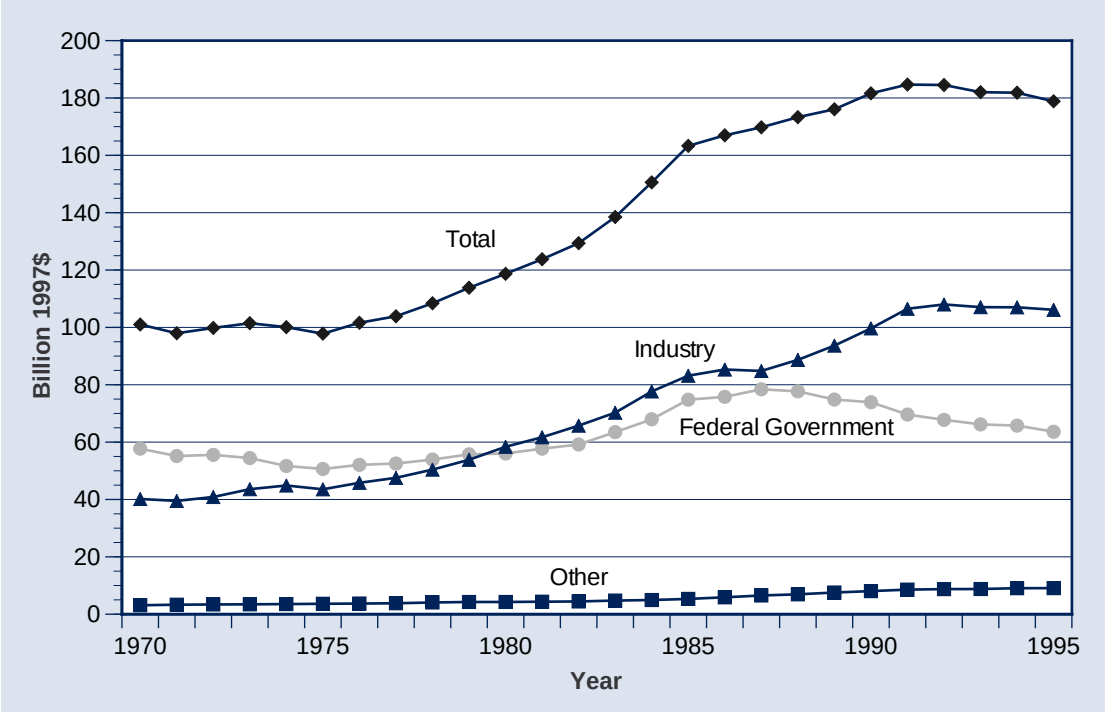


Figure 2B
Total U.S. R&D expenditure by source of funds, 1970–95



The U.S. Energy Landscape

Energy is the lifeblood of our economy, and energy consumption grows with gross national product (GDP.) From 1970 to 1996, total U.S. primary energy consumption rose by almost 50 percent, from about 66.4 quadrillion BTU (quads) to about 93.8 quads. In the same time period, GDP more than doubled. This energy and GDP relationship reflects improvements in the use of energy in this country as a result of technical progress and changes in the composition of the U.S. economy.

Energy Consumption

Total energy consumption in the United States is determined by income level, economic activities, lifestyle, consumer preference, and a number of other economic factors. Energy is consumed in the four basic demand sectors of our economy: transportation, industry, residential, and commercial. In addition to energy used directly by these sectors, large amounts of energy are used to produce electricity.

Transportation accounted for about 26 percent of our Nation's energy use in 1996. The transportation sector accounts for about 70 percent of all petroleum use in the United States.

Industry accounted for about 37 percent of U.S. energy consumption in 1996. Industry relies on a mix of fuels to produce a myriad of products and services. Petroleum and natural gas continue to be the major industrial fuels, together accounting for roughly 70 percent of direct consumption. Much of the petroleum consumption in the industrial sector is used as a raw material or feedstock.

The residential sector accounted for about 21 percent of total primary energy consumption in 1996. About 50 percent of all primary energy consumption in the residential sector is used for heating rooms and water; air-conditioning accounts for more than 9 percent of consumption; and major appliances (refrigerators, freezers, stovetops, and ovens) are responsible for about 17 percent of residential consumption.

The commercial sector accounted for about 16 percent of total primary energy consumption in 1996. The diversity of building types found in the commercial sector and the variety of functions they perform create a broad range of energy needs.

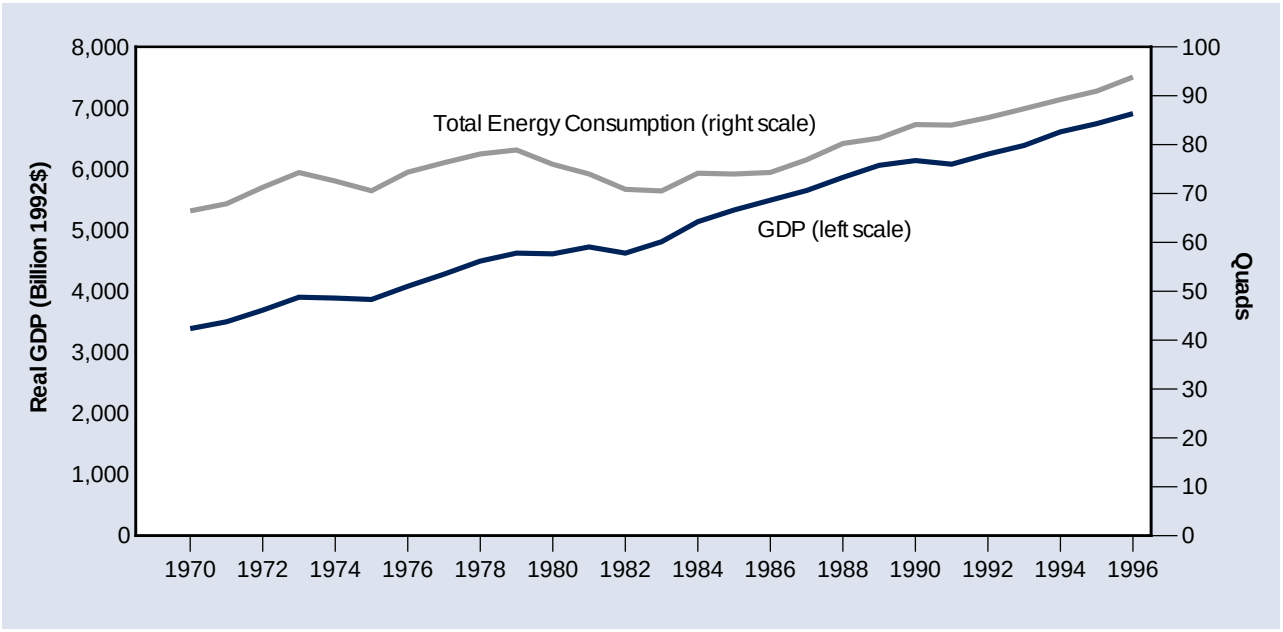
Energy Supply

America's energy resources are extensive and diverse. Coal, oil, natural gas, and uranium are abundant, and a variety of renewable resources are available in large untapped quantities. The United States produces almost twice as much energy as any other nation, and nearly as much as Russia and China combined. Although our Nation uses most of this energy domestically, it exports considerable amounts of coal, refined petroleum products, and enriched uranium.

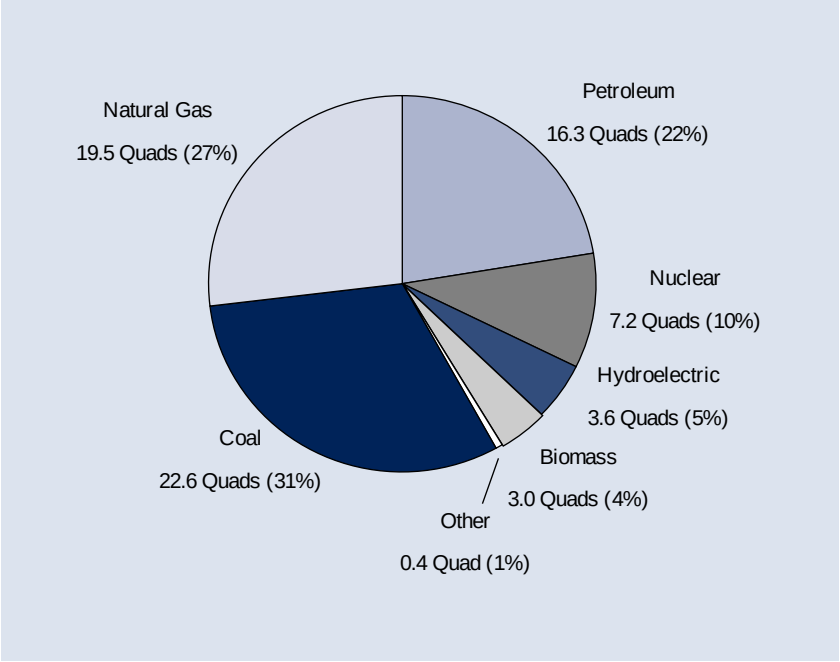
Domestic oil production accounts for about 22 percent of U.S. energy production, down from its pre-embargo share of 32 percent in the early 1970s.

Natural Gas accounted for about 27 percent of U.S. energy

Energy Consumption and GDP, 1970–1996



Energy Production, by fuel, 1996



production in 1996. Although natural gas is produced in 32 States, Texas and its neighboring States, combined with the Federal offshore areas of the Gulf of Mexico, account for 80 percent of U.S. production.

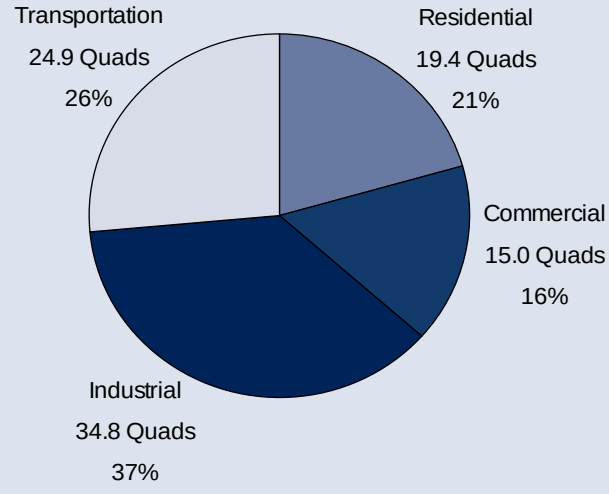
Coal is the Nation's most abundant fossil fuel resource and accounted for about 31 percent of U.S. energy production in 1996. U.S. recoverable reserves of coal are greater than in any other nation, and more than twice those of China, the world's leading coal producer. Every year, the United States produces more than a billion tons of coal and exports about 100 million tons (or 10 percent) to a variety of markets. It uses almost 90 percent of the remainder to generate electricity.

Nuclear energy is the second largest source of U.S. electricity, after coal. The U.S. operates more nuclear powerplants than any other country (more than 100,000 megawatts of capacity); these powerplants produce about 22 percent of our electricity, without emitting carbon dioxide, nitrogen oxides, sulfur oxides, or particulate matter. Many U.S. nuclear plants are approaching the end of their initial Nuclear Regulatory Commission licenses, and their life extension is uncertain because of their economic viability, currently pending technical issues, and public perceptions.

Renewable energy includes hydropower, biomass (primarily wood and waste), geothermal, wind, and solar resources. These sources currently provide about 10 percent of U.S. primary energy production. Although more than half of the U.S. renewable energy produced is used to generate electricity, it is also used for transportation fuels (such as ethanol), and for heating industrial processes (such as wood waste in the paper industry), buildings, and water. Renewable sources of electricity are dominated by conventional hydroelectric power, which provides 80 percent of all renewable electricity and 10 percent of total generation.

Electricity generation represents the conversion of energy from a primary source (fossil fuel, uranium, or renewable forms) into a clean, easily transported, and flexible secondary energy source with innumerable uses. U.S. electricity generation has grown almost every year during the past four decades. The United States is the world's largest producer of electricity, generating more than all of western Europe and Japan combined. More than half of all electricity is generated by burning coal; about one-fifth is derived from nuclear powerplants; renewable resources — primarily hydropower — provide about one-eighth; and the remainder is fueled by natural gas (about 11 percent) and by a small amount of oil (about 2 to 3 percent).

Energy Consumption, by end-use sector, 1996



Global Economic Transformation and Energy Security

The end of the Cold War unleashed market forces in one country after another, and many countries are in the process of transforming cumbersome government-run energy sectors into ones based on private enterprise. At the same time, economic policies in the developing world have led to double-digit growth rates, significant increases in energy demand, and substantial inflows of private capital to finance expanding energy sectors. Most of the global energy economy is now directed by market forces as opposed to government fiat. [Fig. 3.]

Projections of brisk growth in world oil demand substantially change the energy security outlook. In oil production, geology is destiny. Roughly two-thirds of the world's proven oil resources lie in the Persian Gulf region. Even with development of the resources in the Caspian region, rapid growth in world oil demand will largely be met through growth in Persian Gulf oil exports. Excessive reliance on a single geographic area to satisfy increased world demand for oil creates the potential for oil importing nations to be vulnerable to supply disruptions and price volatility. [Fig. 4.]

Competition Comes to the U.S. Electricity Market

Closer to home, the success of oil and natural gas price decontrol, along with the consumer benefits flowing from deregulation of other sectors dominated by regulated monopolies, have motivated consideration of deregulating major portions of the nation's electric power industry. Federal legislation enacted in the late 1970s and early 1990s has opened the wholesale power generation sector of this industry to competition, and several States are in the process of implementing competition in retail markets. While States with relatively high electricity rates have led the way in aggressively pursuing competition, most States have begun to examine prospects for competition to lower prices. [Fig. 5.]

Figure 3
World Energy Use, 1970–95

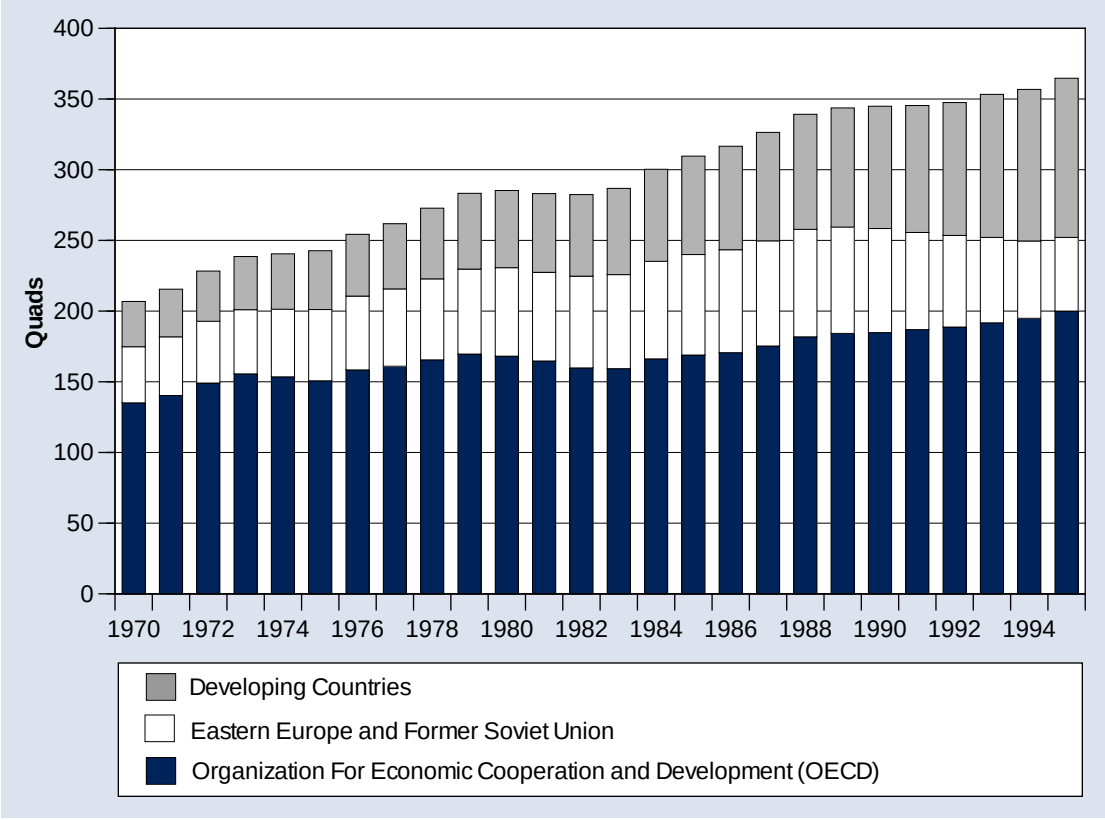


Figure 4
Persian Gulf share of world's oil exports, 1970–2010

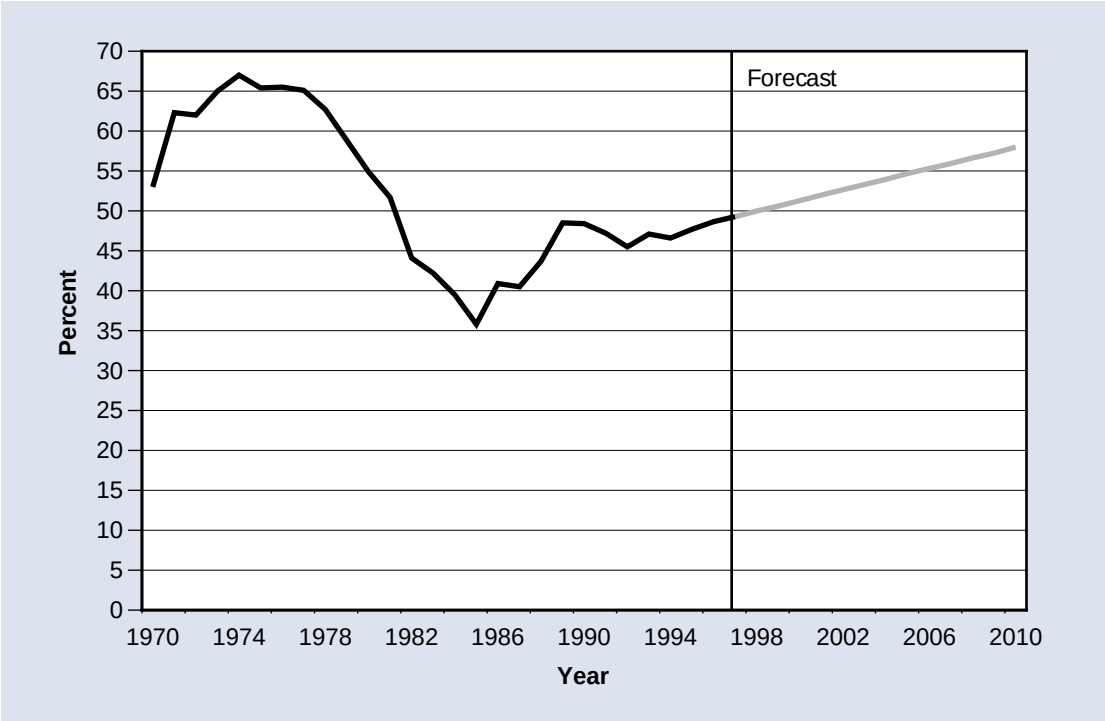
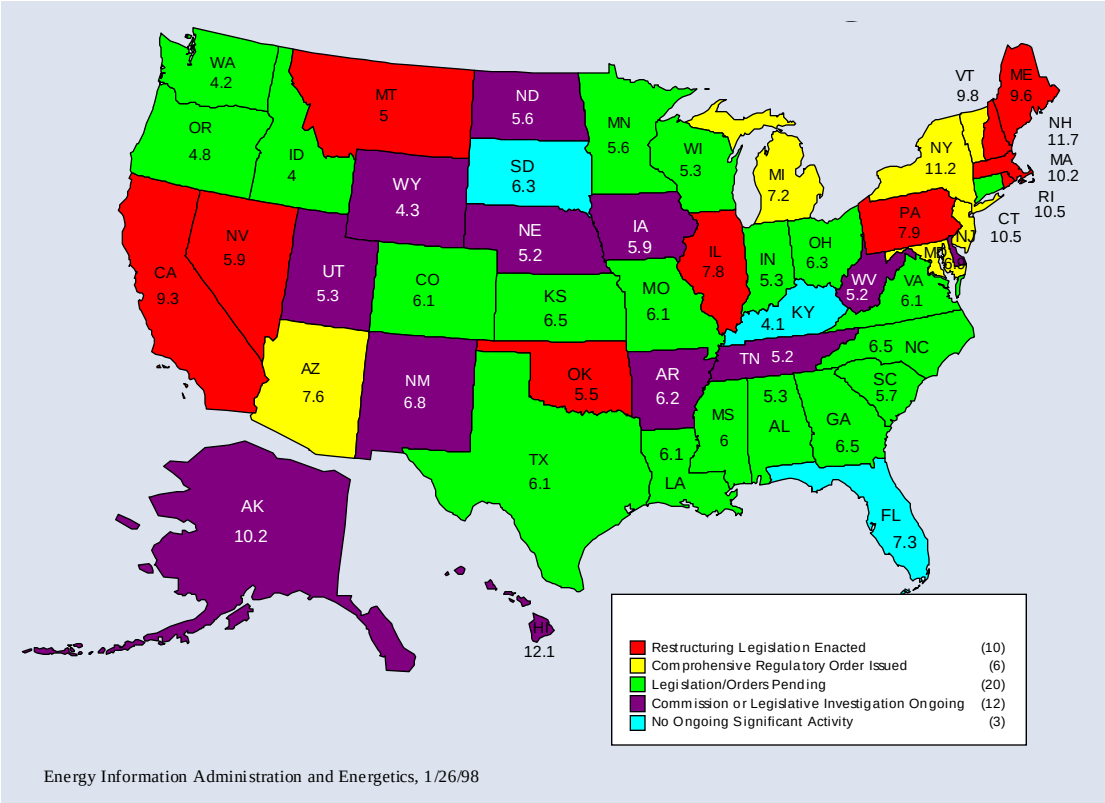


Figure 5
Electric power industry restructuring activities showing current State average electricity rates (cents per kilowatthour)



International Response to Climate Change

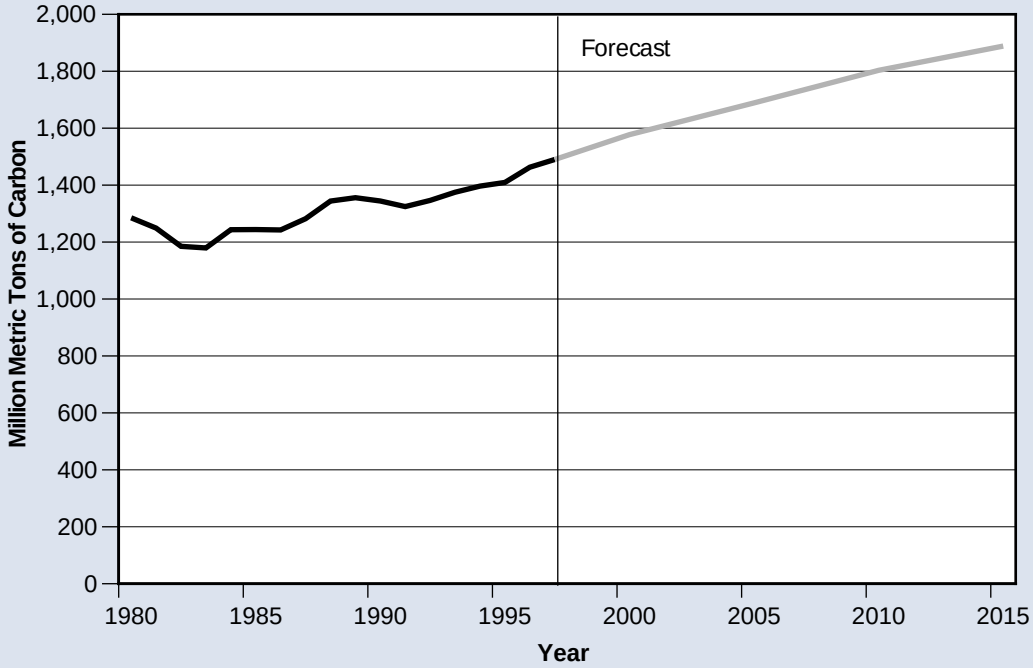
The 1990s have seen the maturation of the global climate change debate from an issue discussed largely among scientists to one that engages the collective attention of governments around the world. In December 1997, the international community negotiated the Kyoto Protocol to the Framework Convention on Climate Change, which assigns developed countries ambitious targets for reducing greenhouse gas emissions. With more than 80 percent of greenhouse gas emissions being energy related, energy policy has a new and demanding role. [Fig. 6.]

The Kyoto Protocol calls for the United States, the world's largest emitter of greenhouse gasses, to reduce its emissions to 7 percent below 1990 levels by the period 2008–2012. (More precisely, the reduction called for is 7 percent below a baseline of 1990 levels for the bulk of emissions and 1995 levels for three synthetic greenhouse gases.) This target entails significant emissions reductions when compared with recent projections, though not all of the emissions reductions will come from energy sectors. Thus, the Kyoto Protocol sets us on a very different course toward an important and challenging goal. Attaining this target while preserving U.S. industrial competitiveness will require a blend of market-oriented policies with structured government involvement.

Proposed National Energy Goals

The basic energy policy for the United States in recent years has involved reliance on markets to allocate most resources with selective government intervention to increase the provision of certain items demanded by society, such as energy security, environmental quality, and energy research. While this general reliance on a market-based approach to meeting energy challenges has endured, the precise blend of market reliance and government action through regulation, technology support, and insurance mechanisms is subject to substantial debate, as is healthy in an open society. Some of the positions are grounded in different perceptions of market shortcomings and risks, while others are based upon varying degrees of emphasis on specific policy goals or disagreement over the best strategies to be used.

Figure 6
U.S. greenhouse gas emissions to 2015, base case



Sources: Historical values are from EIA. Forecast values are from EIA *Annual Energy Outlook 1998* Baseline Projection.

In the past 5 years, the Clinton Administration has pursued an energy policy that has provided substantial economic, environmental, and national security benefits for the American public. However, this policy has been based on a legislative and regulatory framework last revised in the early 1990s. It is now time to take stock of our Nation's energy progress, identify the most substantial challenges that remain, calibrate our energy policy goals to the new century, and propose long-term solutions.

In the context of pursuing a market-based energy policy, the Comprehensive National Energy Strategy proposes five specific goals for the Nation. These goals arise out of the shared desires of all Americans to improve the quality of life through higher living standards, economic security, and a clean environment. A common thread running through our national response to these goals is development and deployment of new technology, enabled through basic scientific and engineering advances. While these goals are not new to this Administration, they are linked with proposed strategies that reflect the changing energy environment. The proposed Energy Strategy Goals are:

- **Improve the efficiency of the energy system** — making more productive use of energy resources in order to enhance overall economic performance while protecting the environment and advancing national security.
- **Ensure against energy disruptions** — protecting our economy from external threat of interrupted supplies or infrastructure failure.
- **Promote energy production and use in ways that reflect human health and environmental values** — improving our health and local, regional, and global environmental quality.
- **Expand future energy choices** — pursuing continued progress in our science and technology to provide future generations with a robust portfolio of clean and reasonably priced energy sources.
- **Cooperate internationally on energy issues** — developing the means to identify, manage, and resolve global economic, security, and environmental concerns.

These goals are interrelated, with tension among some and opportunities for synergy among others. Nevertheless, pursued simultaneously through a comprehensive market-based energy strategy, the attainment of these goals will produce payoffs greater than the sum of their individual components. These goals form a durable framework against which future energy initiatives should be compared to see if they are consistent with the national interest.

Energy Technology: The Essential Basis for Progress

Without energy technologies, a ton of coal, a barrel of oil, a cubic foot of natural gas, a ton of uranium ore, a stiff breeze, or the Sun's warmth cannot directly contribute to the prosperity of modern society. With the very best technologies, however, society can utilize energy resources efficiently and responsibly and with great economic and environmental gain.

While economic and security challenges continue to demand investment in a robust energy research and development program, environmental challenges provide special impetus for increased focus on energy-related science and technology over the next years. Energy use is a principal driver of local and regional environmental problems such as emission of fine particulates and the creation of smog and acid precipitation from nitrogen and sulfur oxides. On a global scale, there is little doubt that human activities associated with energy production and use have, over the last few decades, significantly altered the composition of atmospheric gases. In particular, the concentration of carbon dioxide, a greenhouse gas, has increased by a third over pre-industrial levels. The great majority of involved scientists agree that "business as usual" greenhouse gas emissions will lead to significant increases in the average global temperature and associated climate changes, although the magnitude and distribution of the ecological and human consequences remain the subject of research and debate. Prudence clearly dictates that new technologies be developed to provide us with the options needed to meet evolving environmental, economic, and security needs.

The imperative for embarking on a strong technology program now is reinforced by recognition of the long times associated with significant change in our energy

infrastructure. Research and development (R&D) itself often takes one or two decades to yield technology breakthroughs. The turnover time for major energy supply and end-use technologies also extends to many decades, as shown in Table 1. Decisions made every day about energy production and use lock in a path for a considerable time. Finally, the residence time of carbon dioxide in the Earth's atmosphere is a century or greater. Thus, today's energy R&D program is needed to enable a healthy and prosperous future in the decades to come.

Over the next 10 to 15 years, advances in energy efficiency offer the greatest opportunity for serving environmental, economic, and security goals. The scale of potential gains is established by the magnitude of our Nation's total energy expenditures (about $500 billion per year) or of total manufacturing expenditures on energy (about $100 billion per year). In electricity generation alone, energy efficiency potentially could be doubled through cogeneration and the application of other technologies. It is particularly important to develop and deploy higher efficiency technology for fossil energy generation, because 85 percent of America's energy currently derives from oil, gas, and coal. Because the contributions of fossil energy are expected to increase further, long-term research and implementation programs aimed at sequestering (or capturing) carbon emissions may also be of great environmental significance.

Renewable energy technologies, those that harness the enormous energy available in natural systems, can be expected to make major contributions to America's energy portfolio in coming decades. They will serve transportation, commercial and residential buildings, and industry with limited environmental impacts. The scale and timing of market penetration will depend on further technological progress and the evolving regulatory framework. In addition, the continued operation and optimization of existing nuclear power plants through advanced technologies may be an important contributor to meeting greenhouse gas emission reduction goals if issues such as nuclear waste disposal and nonproliferation are resolved satisfactorily.

The advances spawned through American innovation will range from improvements seen directly in our everyday lives — much more efficient light bulbs, cars, appliances — to new approaches for large baseload energy sources. We must engage the talent in our universities and national laboratories to advance basic science and engineering research and to partner with the private sector to develop and deploy new technologies. This is a central component of a modern, forward-looking energy strategy.

Table 1: Turnover Times for Energy Supply and End-Use Technologies

Technology	*Turnover time (no. of yrs.)*
Incandescent light bulbs	1–2
Industrial process equipment	3–20
Home appliances	5–15
Oil and gas drilling rigs	5–20[a]
Oil refineries	10–30[a]
Electric power plants	30–50[a]
Residential and commercial buildings	50–100[a]

[a]Although the turnover time for these large installations runs into the decades, some of their subsystems may be replaced on a shorter time scale.

Proposed Comprehensive National Energy Strategy

The proposed Comprehensive National Energy Strategy is based on a framework of goals, objectives, and specific strategies that will enable the Nation to sustain an economically competitive, environmentally responsible, and secure energy sector into the next century. While this strategy relies heavily on private-sector actions to achieve national energy goals, it also provides an important role for government to ensure that public interests, particularly those related to energy security and the environment, are properly protected. Such a strategy will make use of multiple policy instruments, including regulatory, fiscal, and trade policies.

Goal I

Improve the efficiency of the energy system — making more productive use of energy resources to enhance overall economic performance while protecting the environment and advancing national security.

To compete successfully in world markets and to improve living standards, the United States must promote the most productive and efficient use of its energy resources, including its electricity infrastructure, its fossil fuel reserves, and its productive capacity for clean, alternative fuels. In addition, the Federal Government must reinvent how it buys and uses energy. These actions also will help reduce reliance on imported oil from unstable regions of the world.

Objective 1. Support competitive and efficient electric systems.

Strategy 1. Enact legislation to promote the establishment of a competitive electric system with improved environmental performance. The Department of Energy (DOE) estimates that roughly $20 billion per year, or 10 per cent of the Nation's electricity bill, can be saved through electricity system restructuring.

Strategy 2. Increase the efficiency by 70 percent for new coal-fired plants and 50 percent for new gas-fired plants and significantly reduce environmental emissions from aggregate fossil fuel-fired generation by 2010. Expanded research, development, and demonstration (RD&D) support for advanced coal and natural gas electricity generating systems will accelerate market adoption of new technologies in the context of greater competition in the generation sector. Some of these technologies (for example, advanced coal generation) may have substantial markets abroad.

Strategy 3. Increase the efficiency of existing Federal hydropower facilities by 2010. Innovative financing systems could be employed to make cost-effective investments in existing Federal hydropower facilities and transmission systems to increase effective capacity and electrical output.

Objective 2. Significantly increase energy efficiency and the use of clean alternative fuels in the transportation, industrial, and buildings sectors by 2010.

Strategy 1. Develop more efficient and fuel-flexible technologies. Through partnerships with the private sector, developing enabling technology to support commercialization of a full-sized, personal vehicle capable of 80 mpg by 2010 and new fuel cells for stationary and transportation use by 2005 would contribute to this objective. Developing and implementing technology roadmaps and other supporting actions leading to a 25-percent reduction in expected energy consumption of the six most energy-intensive industries in the United States by 2010 also supports this objective.

Strategy 2. Develop and promote the use of clean alternative fuels. Accelerated development of biomass liquid fuels technologies and new voluntary rapid-adoption programs could displace 100 million barrels of oil per year by 2005 and reduce expected energy consumption in the industrial sector by as much as 2 percent by 2010.

Strategy 3. Promote development and use of more efficient mobility technologies. Advanced mass transportation systems (high-speed rail, advanced buses) as well as smart highway systems can reduce transportation fuel consumption over the long term.

Objective 3. Increase the efficiency of Federal energy use.

Strategy 1. Improve the efficiency of energy use in Federal buildings by 30 percent between 1985 and 2005, in accordance with Executive Order 12902. The adoption of new and innovative building technologies by the Federal government can reduce energy costs and provide a strong market for emerging technologies.

Strategy 2. Reduce petroleum use in Federal transportation. Increasing the Federal and postal fleet of alternative-fueled (natural gas, electric, and biofuels) vehicles to 100,000 by 2005 will provide critical support for emerging technologies and spur fueling infrastructure investments.

Strategy 3. Provide Federal technical support and leadership in adopting energy-efficient and renewable technologies. Procurement mechanisms for easy access to "lean, clean, and green" products can accelerate widespread adoption of newer technologies by providing demonstrations of enhanced performance.

Goal II

Ensure against energy disruptions — protecting our economy from external threat of interrupted supplies or infrastructure failure.

Enhancing the security of global and domestic energy markets is one of the best bulwarks against threats to our continued economic prosperity. Disruptions in world oil markets have contributed to several economic slowdowns since the early 1970s. Since then we have made significant progress toward reducing our vulnerability. But there are signs that possible oil market vulnerability could increase in the future. Actions taken to improve the efficiency with which energy is used will help promote this goal as well. We will continue a strong emphasis on emergency preparedness efforts, a renewed emphasis on the stabilization of domestic oil production, and an increased attention to the security of domestic energy systems and related parts of the Nation's critical infrastructure.

Objective 1. Reduce the vulnerability of the U.S. economy to disruptions in oil supply.

Strategy 1. By 2005, first stop and then reverse the decline in domestic oil production. Increased Federal support for R&D in improved oil supply technology can expand domestic oil production while reducing the environmental impacts.

Strategy 2. Maintain readiness to address threats and disruptions to world oil supplies. Maintaining the existing Strategic Petroleum Reserve sites and inventory in drawdown-ready condition, and making investments in drawdown capability, provides a credible deterrent to international oil disruptions and may mitigate economic impacts if they occur.

Strategy 3. Diversify sources of oil available to world oil markets. U.S. policies aimed at removing barriers to development and trade of world oil and gas reserves must be maintained and enhanced through increased bilateral and multilateral trade and investment treaty negotiations.

Strategy 4. By 2010, develop technology options to help reduce expected oil consumption by one million barrels per day. The development of light-duty vehicles with higher fuel economy, new technologies to provide increased production from biomass, natural gas and coal, increased use of more efficient transportation systems, and improvements in the efficiency of oil use in industrial processes can all help limit the expected growth in oil demand, which would otherwise be supplied by increased oil imports.

Objective 2. Ensure energy system reliability, flexibility, and emergency response capability.

Strategy 1. Promote the reliability and flexibility of electricity generation, transmission, and distribution. Proposed legislation for restructuring the electric utility sector will include provisions for enhancing reliability, and Federal R&D support could be increased to accelerate the development of cost-competitive distributed power options not reliant on the utility distribution grid.

Strategy 2. Promote the reliability and flexibility of domestic oil refining, transportation, and storage. Implementation of new air emission regulations that apply to the refining industry should not impair their economic viability and expanded R&D support for low-emission refinery technologies can help lower the cost of environmental compliance.

Strategy 3. Promote the reliability and flexibility of natural gas transportation and storage. Expanded R&D support for the development of natural gas storage technologies can expand system deliverability and resiliency in high-demand market areas.

Goal III

Promote energy production and use in ways that reflect human health and environmental values — improving our health and local, regional, and global environmental quality.

Climate change and other environmental issues present difficult challenges for the energy sector. Our demand for energy, especially for clean and reasonably priced energy sources, is likely to grow over time. New Clean Air Act requirements will impose

additional requirements and costs. Abiding by the Kyoto Protocol will encourage the United States to make significant changes in energy use to reduce greenhouse gas emissions. Substantial improvements in energy technology and flexible market-oriented government policies can permit us to have a growing economy while meeting our environmental aims.

Objective 1. Grow domestic energy production in an environmentally responsible manner.

Strategy 1. Support policies to allow our natural gas supply to grow by up to 6 trillion cubic feet by 2010. About 60 percent of this growth will be used in electricity generating systems. Natural gas technologies are currently the most economic fossil fuel-based technologies for new capacity in electric energy generation.

Strategy 2. Use advanced technologies to recover more oil from reservoirs without significant environmental degradation. Using advanced exploration and recovery technologies can result in more than 400 million barrels of additional oil production by 2005.

Strategy 3. Develop renewable electric energy generation technologies capable of economically doubling nonhydroelectric renewable generation capacity to a total of 25,000 megawatts by the year 2010. Expanded Federal R&D efforts in renewable energy sources would provide a cost-effective complement to efforts to encourage renewables in the context of electric industry restructuring through, for example, a renewable energy portfolio standard.

Strategy 4. Maintain a viable nuclear energy option. Cooperation between the private and public sectors to avoid premature shutdown of viable existing plants and development of new nuclear power technology options for the future can reduce greenhouse gas emissions from the electricity generating sector. This will require resolution of nuclear waste issues and improved public perceptions of safety.

Objective 2. Accelerate the development and market adoption of environmentally-friendly technologies.

Strategy 1. Increase efforts to deploy climate-friendly technologies in the near term. The President's fiscal-year (FY) 1999 budget includes a $5 billion 5-year plan to stimulate the adoption of climate-friendly technologies through a combination of increased spending on research, development, and early deployment programs, and tax incentives for climate-beneficial investments. This will accelerate the diffusion and market adoption of new and existing technologies in ways that generate economic benefits while reducing greenhouse gases.

Strategy 2. Initiate sectoral consultations with U.S. industry to promote expanded voluntary efforts to reduce greenhouse gas emissions. The Administration will seek additional voluntary pledges from major energy-using industries to reduce greenhouse gas emissions, expanding on the successful programs in the electric utility sector and other industries under the initial Climate Change Action Plan of 1993.

Strategy 3. Design a domestic greenhouse gas emission trading system that will help meet binding emission targets in the most cost-effective way. Domestic emission targets likely will be met, in part, through a system of emission allowance trading that builds upon our successful experience in reducing the emissions associated with acid rain. However, a greenhouse gas emission trading system will be more complex and requires substantial analytical development over the next 5 years for effective implementation.

Strategy 4. Participate in negotiations with developing countries regarding their commitments to reduce greenhouse gas emissions. An international agreement to reduce greenhouse gas emissions will be most effective if it includes the participation of key developing countries whose emissions are large and rapidly growing. The Administration will make submission of the Kyoto Protocol for ratification conditional upon the meaningful participation of these countries.

Strategy 5. Promote international joint efforts to reduce greenhouse gas emissions. The development of a viable international emission allowance trading scheme among developed countries and the expansion of efforts to allow developed countries to engage in emission reductions in developing countries while receiving credits for these reductions are critical elements of a globally cost-effective response to climate change. Further develop the understanding of the science related to climate change — carbon

cycles, climate modeling, carbon sequestration — to support international efforts to reduce greenhouse gas emissions.

Goal IV

Expand future energy choices — pursuing continued progress in science and technology to provide future generations with a robust portfolio of clean and reasonably priced energy sources.

The U.S. scientific enterprise is the largest and most successful in the world. Advances in science and technology are critical to achieving our Nation's economic, environmental, and security objectives. Competitive markets tend to underinvest in critical research and development for long-term energy solutions. Government R&D investments — often in collaboration with the private sector — can ensure a steady stream of innovation that benefits the Nation and the world with improved energy technologies.

Objective 1. Maintain a strong national knowledge base as the foundation for informed energy decisions, new energy systems, and enabling technologies of the future.

Strategy 1. Develop science that supports decision making on future energy options, including the requirements of new energy system concepts and their anticipated effects on human health and the physical environment. Improved understanding of energy-related pollution and the development of better analytical techniques for simulating the technical performance of new energy systems will assist the Federal Government and the private sector in making informed energy investment choices.

Strategy 2. Intensify basic research on global climate change and on long-term, innovative systems for carbon cycle management. Research into new technologies to capture and sequester energy-related carbon emissions could greatly expand the portfolio of long-term technology options necessary to manage the relationship between energy use and greenhouse gas emissions.

Strategy 3. Conduct basic research that provides the foundations for long-term energy-technology breakthroughs. Research into the fundamental nature of energy and matter will feed into future innovation in energy technologies.

Strategy 4. Support a strong energy science infrastructure. We must ensure that the Nation's scientists in government, industry, and academia have access to modern, leading-edge research facilities, including major scientific user facilities and the Nation's science laboratories.

Strategy 5. Analyze alternative energy systems and needs for the future. Exploring future energy-sector scenarios and integrated systems concepts, and developing programs and information for long-term energy options will enhance government and private-sector information in long-term investment decisions.

Objective 2. Develop technologies that expand long-term energy options.

Strategy 1. Develop long-term energy technologies that increase energy options, improve overall economics, utilize resources more efficiently, and reduce adverse impacts of energy supply and use. This includes the development of advanced renewable technologies, research into low-cost, proliferation-resistant, nuclear reactor technologies, the development of technologies for safe extraction of methane, and development of technologies for the storage, distribution and conversion of hydrogen.

Goal V

Cooperate internationally on global issues — developing the means to address global economic, security, and environmental concerns.

The energy market is now a global market and how effectively we interact on an international basis will, to a large extent, determine how economically prosperous we remain domestically. Cooperation with foreign governments on energy regulations and laws, promotion and deployment of clean and efficient energy systems worldwide, and international science and technology cooperation aimed at maximizing Federal R&D funds will be important determining elements in how well we succeed in achieving our energy, economic, and environmental goals and objectives. The responsible transfer of energy technologies will also play an important role in international cooperative activities. Finally, international cooperation and collaboration will be needed to address global environmental issues such as climate change.

Objective 1. Promote development of open, competitive international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

Strategy 1. Cooperate with foreign governments and international institutions to develop energy-sector laws, policies, and regulatory processes for setting standards and enforcing regulations. This includes fostering the development and implementation of appropriate policies and regulations through active and sustained participation in multilateral international and regional energy forums, and through constructive bilateral engagement with key countries.

Strategy 2. Promote deployment of clean and efficient energy systems. Promoting the export of clean, energy-efficient, and cost-effective technologies through partnerships with energy industries, trade associations, and multilateral agencies, the Federal Government should help to identify hundreds of millions of dollars in market opportunities each year.

Strategy 3. Promote international science and technology collaboration to avoid duplication and maximize the national benefits of Federal R&D efforts. Supporting the expansion of international R&D collaboration and facilitating international joint ventures to accelerate technology commercialization are consistent with the recommendations of the President's Committee of Advisors on Science and Technology.

Objective 2. Promote foreign regional stability by reducing energy-related environmental risks in areas of U.S. security interest.

Strategy 1. Promote foreign capacity building and solutions to environmental security concerns, integrating the capabilities of DOE and other agencies, foreign governments, the private sector, and nongovernmental organizations. The identification, assessment, and prioritization of environmental security concerns in selected world regions of importance to the United States will help point to cost-effective solutions to potential threats to U.S. national security interests.

A Shared Commitment

A broad consensus on overarching energy policy goals does not ensure achievement of better energy and environmental outcomes. The vast array of participants in energy markets — firms, nations and their government agencies, public and private research facilities, advocacy groups, and individual citizens — have differing and perhaps changing perspectives on their roles and actions, even if they agree on the broad goals. Even if the entire choir has the same songbook, harmony will not result if everyone is singing from a different page. A fundamental challenge facing the United States is to harmonize these potentially discordant interests into making shared contributions to meeting the shared objectives.

The goals of the Comprehensive National Energy Strategy require a shared commitment if they are to be achieved. The various Federal agencies need to cooperate and coordinate activities in pursuit of these goals, with involvement at all levels and by making use of the unparalleled resources of the national laboratories. Similarly, the several branches of government must share in the belief that pursuit of these goals is a priority, when resource commitments are being made. The commitment must extend beyond government to the private sector, which will be engaged through public-private partnerships, built on the recognition that meeting these goals is in the long-term interest of everyone involved. The nonprofit sector, especially universities, also must make a commitment to pursue these goals in order to mobilize the unique resources contained in these institutions. Communities also must share in the commitment to achieve these goals, for the benefits of meeting them extend far beyond any single business or individual. Finally, countries must share in the commitment to meet these goals, for many of the benefits are global in nature, and the resources and knowledge base to address these goals generally are not concentrated solely in the United States. These shared commitments will maximize the probability of successfully attaining these national goals, without devoting unreasonable amounts of resources to this effort. If success is achieved, we will leave future generations of Americans a more livable country and a thriving energy sector with a wide variety of useful and safe energy alternatives.